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Cho et al.

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(54) **SEMICONDUCTOR LIGHT EMITTING DIODE AND METHOD FOR MANUFACTURING THE SAME**

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H01L 33/00 (2010.01)

(52) **U.S. Cl.**
CPC ***H01L 33/24*** (2013.01); *H01L 33/007* (2013.01)

(58) **Field of Classification Search**
CPC H01L 33/24
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0065881 A1* 3/2010 Kim 257/99

FOREIGN PATENT DOCUMENTS

KR 1020100006547 A 1/2010

* cited by examiner

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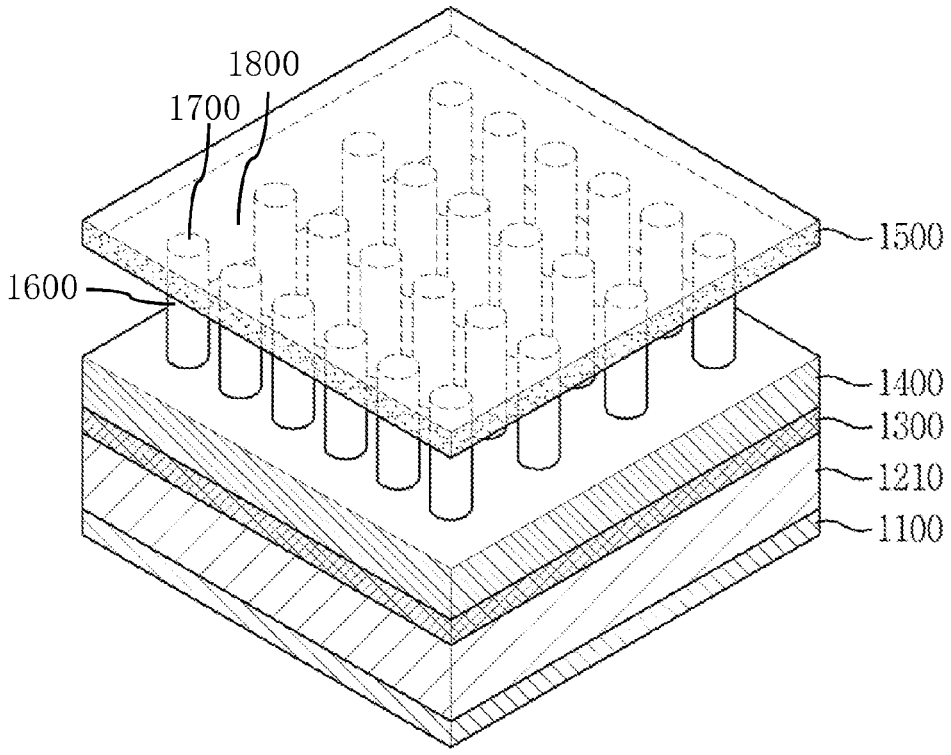
(57) **ABSTRACT**

A semiconductor light emitting diode is provided. The semiconductor light emitting diode comprises a metal electrode; an n-type cladding over the metal electrode, the n-type cladding comprising a pillar support part formed of an n-type semiconductor material, and a pillar part having a plurality of pillars formed of an n-type semiconductor material over the pillar support part; an active part conformally formed over the pillar part so as to enclose the pillar part and over the pillar support part between the pillar parts, the active part having a quantum well layer and a barrier layer stacked alternately; a p-type cladding conformally formed of a p-type semiconductor material over the active part; and a transparent electrode formed over the p-type cladding.

16 Claims, 7 Drawing Sheets



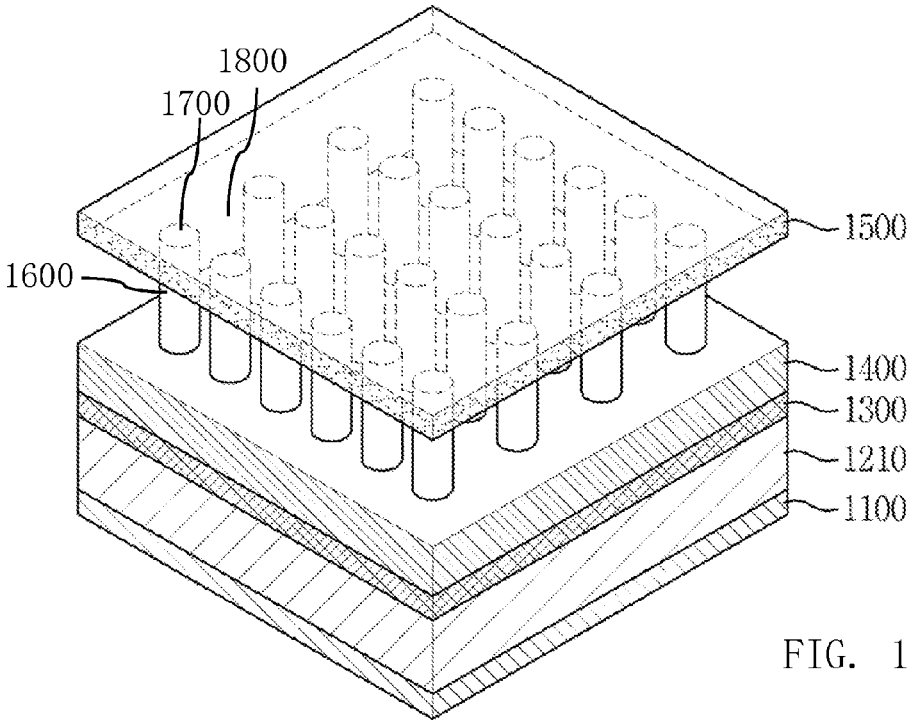

1800
1700
1500
1600
1400
1300
1210
1100

FIG. 1

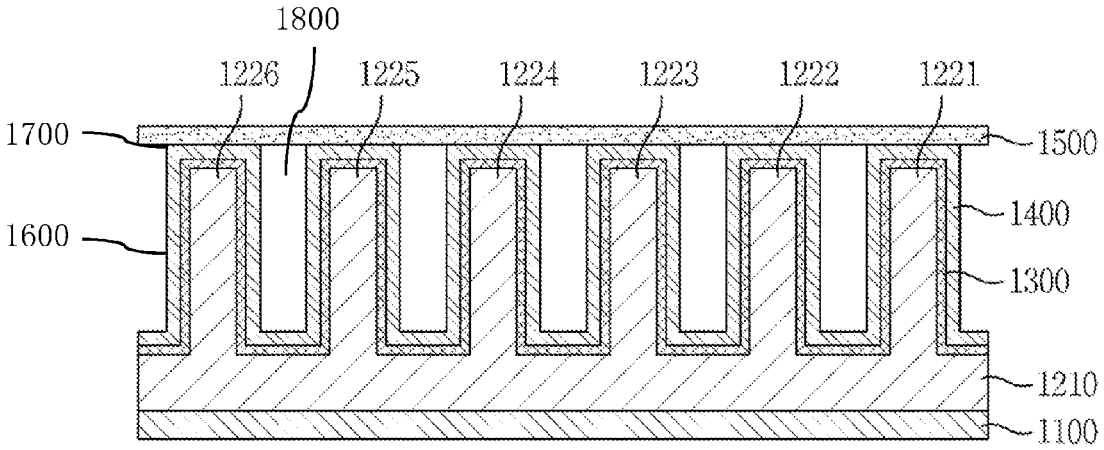

1800
1226
1225
1224
1223
1222
1221
1700
1500
1600
1400
1300
1210
1100

FIG. 2

FIG. 3a

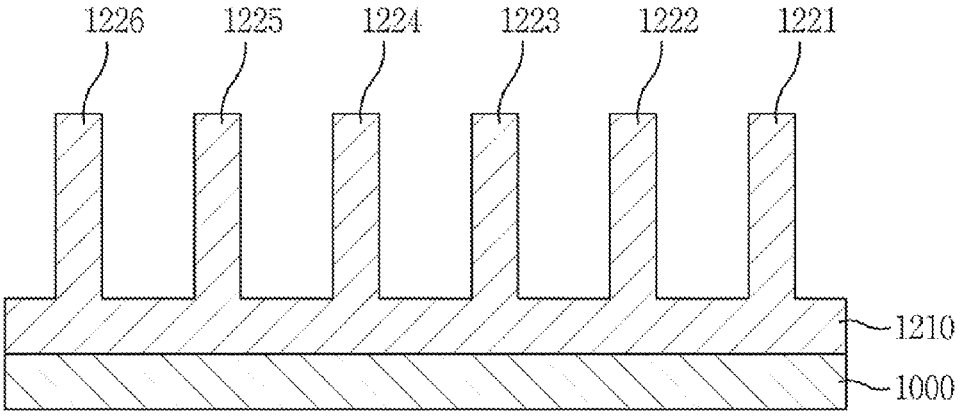


FIG. 3b

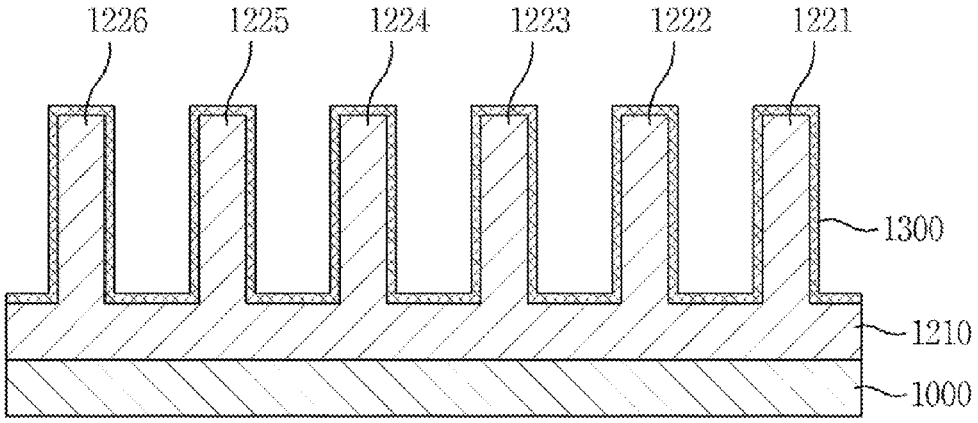
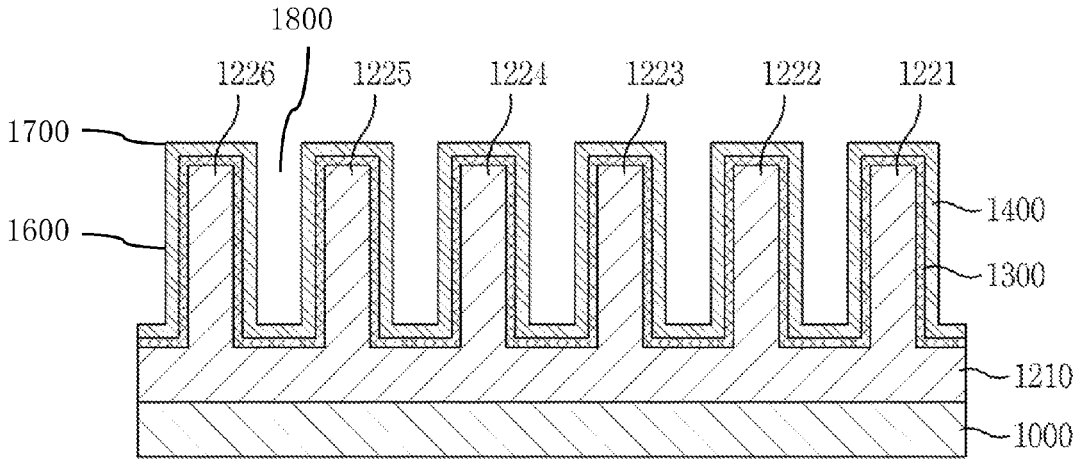


FIG. 3c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1226
1225
1224
1223
1222
1221
1700
1600
1400
1300
1210
1000

FIG. 3d

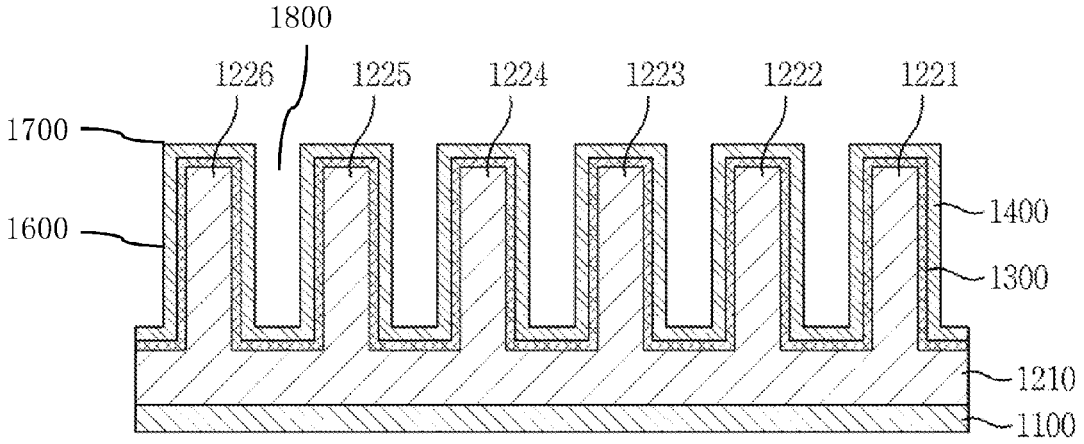
1800
1226
1225
1224
1223
1222
1221
1700
1600
1400
1300
1210
1100

FIG. 3e

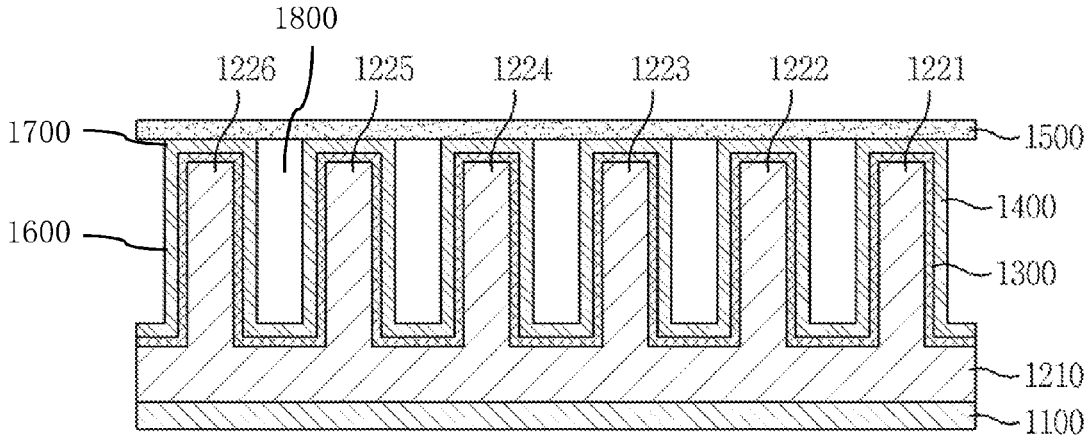
1800
1226
1225
1224
1223
1222
1221
1700
1500
1600
1400
1300
1210
1100

FIG. 3f

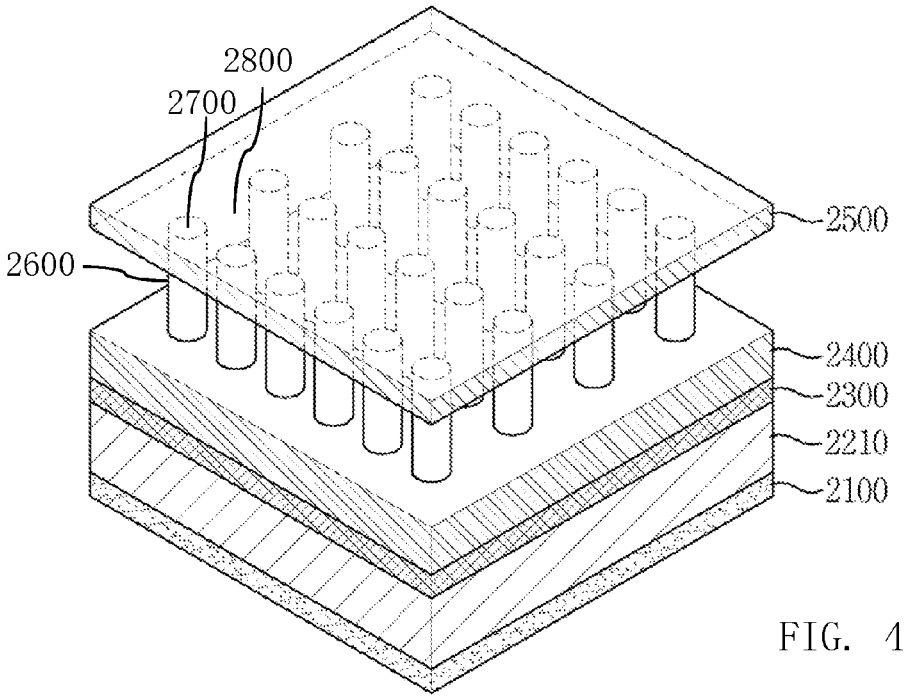
2800
2700
2500
2600
2400
2300
2210
2100

FIG. 4

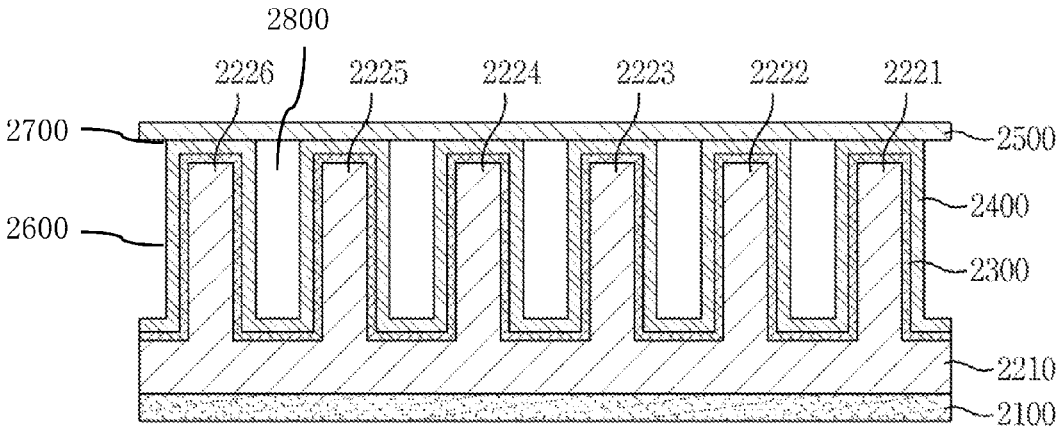
2800
2226
2225
2224
2223
2222
2221
2700
2500
2600
2400
2300
2210
2100

FIG. 5

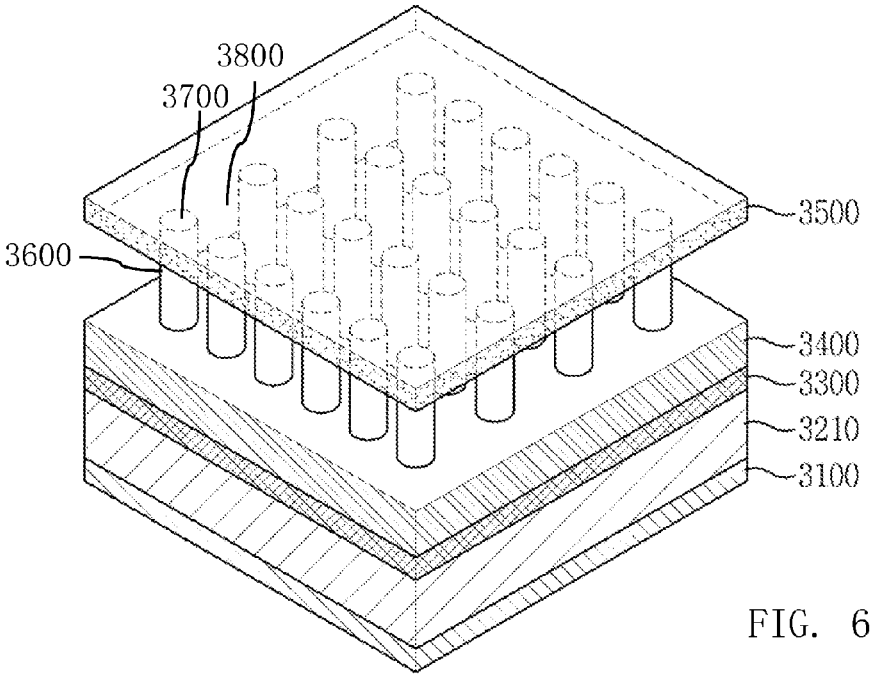
3800
3700
3500
3600
3400
3300
3210
3100

FIG. 6

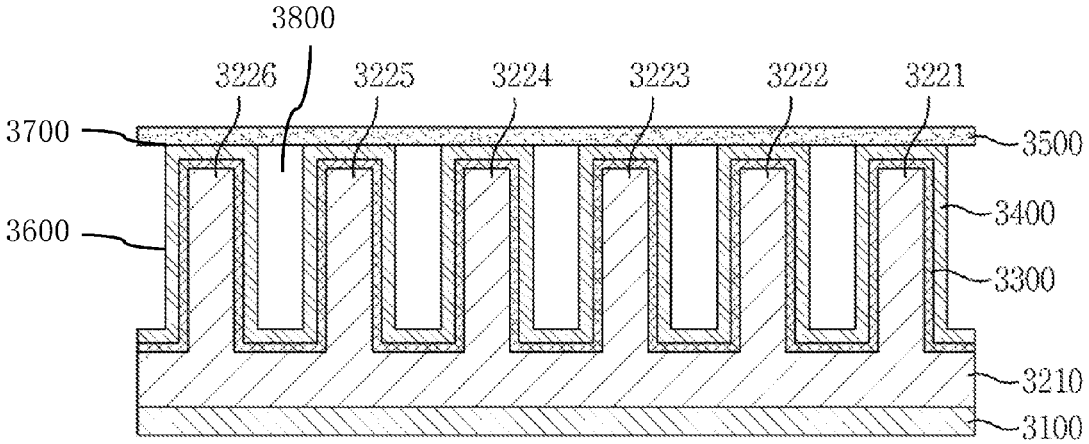
3800
3226
3225
3224
3223
3222
3221
3700
3500
3600
3400
3300
3210
3100

FIG. 7

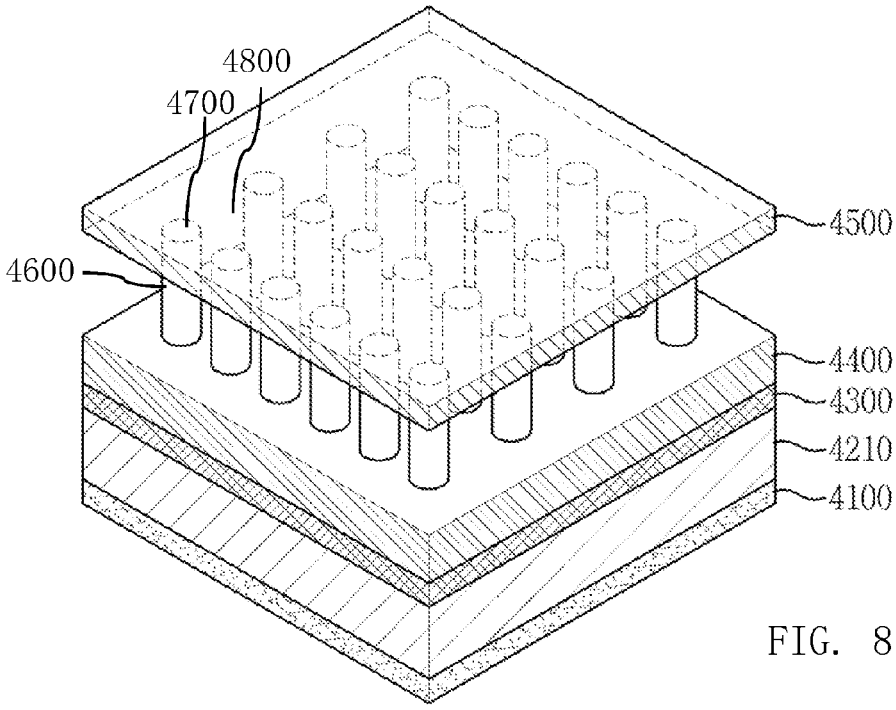
4800
4700
4500
4600
4400
4300
4210
4100

FIG. 8

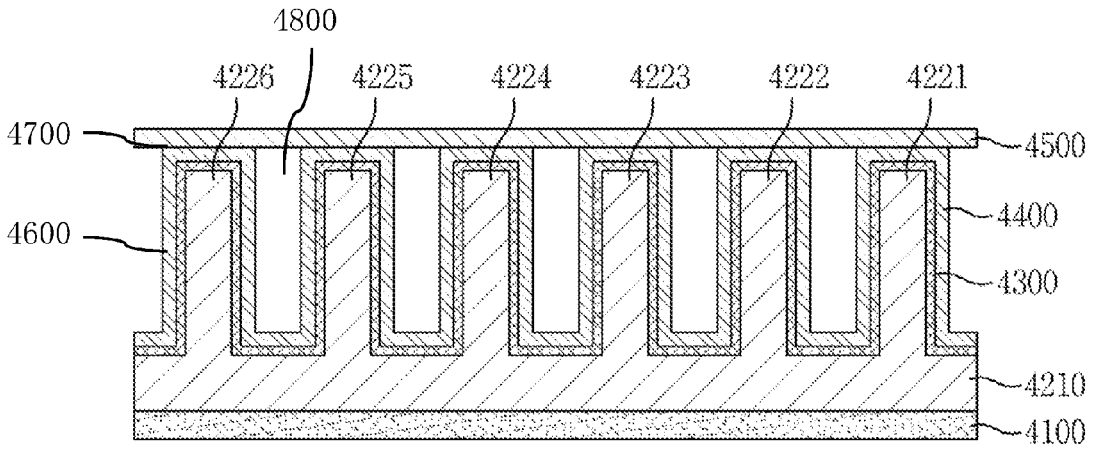
4800
4226
4225
4224
4223
4222
4221
4700
4500
4600
4400
4300
4210
4100

FIG. 9

SEMICONDUCTOR LIGHT EMITTING DIODE AND METHOD FOR MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority under 35 U.S.C. 119 and 35 U.S.C. 365 to Korean Patent Application No. 10-2011-0073678 filed on Jul. 25, 2011, which is hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

The present disclosure relates to a semiconductor light emitting diode emitting visible or ultraviolet wavelength light, and a method for manufacturing the same, and more particularly, to a semiconductor light emitting diode that can effectively increase the effective light emitting area by forming a cladding including a pillar part and a pillar support part and conformally forming an active layer over the pillar part and the pillar support part, and a method for manufacturing the same.

BACKGROUND

Recently, a semiconductor light emitting diode (LED) in which aluminum (Al) or indium (In) is added in GaN is in the spotlight as a next generation light emitting device that can save energy consumption, and expands its applications to the fields of visible rays and ultraviolet rays.

To improve the light emitting efficiency of the above-mentioned semiconductor light emitting diode, Korean Patent Publication No. 10-2010-0006547 discloses a method for forming an active layer emitting light in a multi quantum well structure.

The semiconductor light emitting diode disclosed in the above cited document, however, has a difficulty in securing a sufficient effective light emitting area to decrease a loss of the light emitting area.

SUMMARY

Embodiments provide a semiconductor light emitting diode that can effectively increase the effective light emitting area by forming a cladding including a pillar part and a pillar support part, and conformally forming an active layer on the pillar part and the pillar support part.

Embodiments also provide a method for manufacturing a semiconductor light emitting diode that can easily manufacture the foregoing semiconductor light emitting diode.

The technical objects of the present disclosure are not limited to the aforesaid, and other technical objects not described herein will be clearly understood by those skilled in the art from descriptions below.

In one embodiment, a semiconductor light emitting diode includes: a metal electrode; an n-type cladding over the metal electrode, the n-type cladding including a pillar support part formed of an n-type semiconductor material, and a pillar part having a plurality of pillars formed of an n-type semiconductor material over the pillar support part; an active part conformally formed over the pillar part so as to enclose the pillar part and over the pillar support part between the pillar parts, the active part having a quantum well layer and a barrier layer stacked alternately; a p-type cladding conformally formed of a p-type semiconductor material over the active part; and a transparent electrode formed over the p-type cladding.

In another embodiment, a semiconductor light emitting diode includes: a transparent electrode; an n-type cladding over the transparent electrode, the n-type cladding including a pillar support part formed of an n-type semiconductor material, and a pillar part having a plurality of pillars formed of an n-type semiconductor material over the pillar support part; an active part conformally formed over the pillar part so as to enclose the pillar part and over the pillar support part between the pillar parts, the active part having a quantum well layer and a barrier layer stacked alternately; a p-type cladding conformally formed of a p-type semiconductor material over the active part; and a metal electrode formed over the p-type cladding.

In further another embodiment, a semiconductor light emitting diode includes: a metal electrode; a p-type cladding over the metal electrode, the p-type cladding including a pillar support part formed of a p-type semiconductor material, and a pillar part having a plurality of pillars formed of a p-type semiconductor material over the pillar support part; an active part conformally formed over the pillar part so as to enclose the pillar part and over the pillar support part between the pillar parts, the active part having a quantum well layer and a barrier layer stacked alternately; an n-type cladding conformally formed of an n-type semiconductor material over the active part; and a transparent electrode formed over the n-type cladding.

In still further another embodiment, a semiconductor light emitting diode includes: a transparent electrode; a p-type cladding over the transparent electrode, the p-type cladding including a pillar support part formed of a p-type semiconductor material, and a pillar part having a plurality of pillars formed of a p-type semiconductor material over the pillar support part; an active part conformally formed over the pillar part so as to enclose the pillar part and over the pillar support part between the pillar parts, the active part having a quantum well layer and a barrier layer stacked alternately; an n-type cladding conformally formed of an n-type semiconductor material over the active part; and a metal electrode formed over the n-type cladding.

In yet further another embodiment, a method for manufacturing a semiconductor light emitting diode includes: forming an n-type cladding over a semiconductor substrate, the n-type cladding including a pillar support part formed of an n-type semiconductor material, and a pillar part having a plurality of pillars formed of an n-type semiconductor material over the pillar support part; forming an active part by alternately and conformally stacking a quantum well layer and a barrier layer over the pillar part and over the pillar support part between the pillar parts; conformally forming a p-type cladding of a p-type semiconductor material over the active part; forming a transparent electrode over the p-type cladding; and forming a metal electrode over a bottom surface of the pillar support part where the pillar part is not formed.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a semiconductor light emitting diode according to a first embodiment.

FIG. **2** is a cross-sectional view of a semiconductor light emitting diode according to a first embodiment.

FIGS. **3**A to **3**F are cross-sectional views illustrating a method for manufacturing a semiconductor light emitting diode according to a first embodiment.

FIG. **4** is a perspective view of a semiconductor light emitting diode according to a second embodiment.

FIG. **5** is a cross-sectional view of a semiconductor light emitting diode according to a second embodiment.

FIG. **6** is a perspective view of a semiconductor light emitting diode according to a third embodiment.

FIG. **7** is a cross-sectional view of a semiconductor light emitting diode according to a third embodiment.

FIG. **8** is a perspective view of a semiconductor light emitting diode according to a fourth embodiment.

FIG. **9** is a cross-sectional view of a semiconductor light emitting diode according to a fourth embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

In an embodiment, a semiconductor light emitting diode may include a metal electrode **1100**, an n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226**, an active part **1300**, a p-type cladding **1400**, and a transparent electrode **1500**, as illustrated in FIGS. **1** and **2**.

The n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** includes a pillar supporting part **1210** formed of an n-type semiconductor material over the metal electrode **1100**, and a pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** having a plurality of pillars and formed of an n-type semiconductor material over the pillar supporting part **1210**. The n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** may be formed of an n-type GaN.

Meanwhile, the active part **1300** is conformally formed over the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** so as to enclose the pillar parts **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** and the pillar supporting part between the pillar parts **1221**, **1222**, **1223**, **1224**, **1225**, and **1226**, and includes a quantum well layer and a barrier layer stacked alternately.

Furthermore, the active part **1300** may include an AlGaN quantum well layer and an AlGaN barrier layer stacked alternately, or a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately, if necessary.

Also, the p-type cladding **1400** is conformally formed of a p-type semiconductor material, e.g., a p-type GaN, over the active layer **1300**.

Further referring to FIG. **2**, in some embodiments, pillar parts **1221-1226** that have a plurality of pillars and are formed of an n-type semiconductor material conformally over the pillar supporting part **1210**, the active part or layer **1300** that is conformally formed over the plurality of pillars of pillar parts **1221-1226** and over the pillar supporting part **1210** between the plurality of pillars, and the p-type cladding **1400** that is conformally formed over the active layer **1300**, constitute a plurality of the columns **1600**. The plurality of the columns **1600** may be configured to maintain a space **1800** between each column of the plurality of columns **1600**. The transparent electrode **1500** may be situated over a top of the plurality of columns **1600**. For example, the transparent electrode **1500** may physically touch only an uppermost surface or face of each column **1700** of the plurality of columns **1600**.

The transparent electrode **1500** is formed of a transparent material, such as indium tin oxide (ITO), fluorine-doped tin oxide (FTC)), or the like over the p-type cladding **1400**.

Hereinafter, a method for manufacturing a semiconductor light emitting diode according to a first embodiment will be described with reference to FIGS. **3**A to **3**F.

First, as illustrated in FIG. **3**A, a pillar supporting part **1210** for an n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** is formed of an n-type semiconductor material over a semiconductor substrate **1000**, such as a sapphire substrate, by using an atomic layer deposition (ALD). The pillar supporting part **1210** for the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** may be formed of an n-type GaN.

Subsequently, a pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** having a plurality of pillars for the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** is formed of an n-type semiconductor material over the pillar supporting part **1210**. The pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** for the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** may be formed of an n-type GaN.

Alternatively, the pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** may be formed by forming a bulk layer over the semiconductor substrate **1000** by using an atomic layer deposition (ALD) or the like and then patterning the bulk layer by using an etch process.

As another alternative, the pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** for the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** may be formed by forming a photo resist pattern partially exposing the pillar supporting part **1210** of n-type semiconductor material and then selectively depositing an n-type semiconductor material over the exposed pillar supporting part **1210** of n-type semiconductor material

Subsequently, the active part **1300** is conformally formed over the n-type cladding **1210**, **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** so as to enclose the pillar parts **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** and the pillar supporting part between the pillar parts **1221**, **1222**, **1223**, **1224**, **1225**, and **1226**, and includes a quantum well layer and a barrier layer stacked alternately.

In detail, an AlGaN quantum well layer and an AlGaN barrier layer are conformally stacked over the pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** and over the pillar supporting part **1210** between the plurality of pillars **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** by using an ALD or the like.

The active part **1300** may include a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately, if necessary.

Next, a p-type cladding layer **1400** is conformally formed of a p-type semiconductor material over the active part **1300** by using an ALD or the like. The p-type cladding **1400** may be formed of a p-type GaN.

Subsequently, the semiconductor substrate **1000** is removed, and then a metal electrode **1100** is formed of a reflective conductive material, such as titanium, silver, copper alloy, or the like over a bottom surface of the pillar supporting part **1210** where the pillar part **1221**, **1222**, **1223**, **1224**, **1225**, and **1226** is not formed, by using a sputtering, electroplating, or the like.

Next, a transparent electrode **1500** is formed of a transparent conductive material, such as ITO, FTO, or the like over the p-type cladding **1400** by using a sputtering.

While the present embodiment shows and describes that the metal electrode **110** is first formed before the transparent electrode **1500**, the forming sequence of the metal electrode **1100** and the transparent electrode **1500** may be reversed. For example, the transparent electrode **1500** is first formed and then the metal electrode **1100** may be formed.

A semiconductor light emitting diode according to a second embodiment will now be described with reference to

FIGS. **4** and **5**. For convenience of description, only differences from the semiconductor light emitting diode according to the first embodiment will be described.

In a semiconductor light emitting diode according to a second embodiment, an n-type cladding **2210**, **2221**, **2222**, **2223**, **2224**, **2225**, and **2226** including a pillar supporting part **2210** formed of an n-type semiconductor material over a transparent electrode **2100**, and a pillar part **2221**, **2222**, **2223**, **2224**, **2225**, and **2226** having a plurality of pillars formed of an n-type semiconductor material over the pillar supporting part **2210** is formed, and a metal electrode **2500** is formed over a p-type cladding **2400**. In some embodiments, pillar parts **2221-2226** that have a plurality of pillars and are formed of an n-type semiconductor material conformally over the pillar supporting part **2210**, an active part or layer **2300** that is conformally formed over the plurality of pillars of pillar parts **2221-2226** and over the pillar supporting part **2210** between the plurality of pillars, and a p-type cladding **2400** that is conformally formed over an active layer **2300**, constitute a plurality of the columns **2600**. The plurality of the columns **2600** may be configured to maintain a space **2800** between each column of the plurality of columns **2600**. The metal electrode **2500** may be situated over a top of the plurality of columns **2600**. For example, the transparent electrode **2500** may physically touch only an uppermost surface or face of each column **2700** of the plurality of columns **2600**.

A semiconductor light emitting diode according to a third embodiment will now be described with reference to FIGS. **6** and **7**. For convenience of description, only differences from the semiconductor light emitting diode according to the first embodiment will be described.

In a semiconductor light emitting diode according to a third embodiment, a p-type cladding **3210**, **3221**, **3222**, **3223**, **3224**, **3225**, and **3226** including a pillar supporting part **3210** formed of a p-type semiconductor material over a metal electrode **3100**, and a pillar part **3221**, **3222**, **3223**, **3224**, **3225**, and **3226** having a plurality of pillars formed of a p-type semiconductor material over the pillar supporting part **3226** is formed, an n-type cladding **3400** is conformally formed of an n-type semiconductor material over an active part **3300**, and a transparent electrode **3500** is formed over the n-type cladding **3400**. In some embodiments, pillar parts **3221-3226** that have a plurality of pillars and are formed of a p-type semiconductor material conformally over the pillar supporting part **3210**, an active part or layer **3300** that is conformally formed over the plurality of pillars of pillar parts **3221-3226** and over the pillar supporting part **3210** between the plurality of pillars, and the n-type cladding **3400** that is conformally formed over the active layer **3300**, constitute a plurality of the columns **3600**. The plurality of the columns **3600** may be configured to maintain a space **3800** between each column of the plurality of columns **3600**. The transparent electrode **3500** may be situated over a top of the plurality of columns **3600**. For example, the transparent electrode **3500** may physically touch only an uppermost surface or face of each column **3700** of the plurality of columns **3600**.

A semiconductor light emitting diode according to a fourth embodiment will now be described with reference to FIGS. **8** and **9**. For convenience of description, only differences from the semiconductor light emitting diode according to the first embodiment will be described.

In a semiconductor light emitting diode according to a fourth embodiment of the present disclosure, a p-type cladding **4210**, **4221**, **4222**, **4223**, **4224**, **4225**, and **4226** including a pillar supporting part **4210** formed of a p-type semiconductor material over a transparent electrode **4100**, and a pillar part **4221**, **4222**, **4223**, **4224**, **4225**, and **4226** having a plurality of pillars formed of a p-type semiconductor material over the pillar supporting part **4210** is formed, and a metal electrode **4500** is formed over an n-type cladding **4400**. In some embodiments, pillar parts **4221-4226** that have a plurality of pillars and are formed of a p-type semiconductor material conformally over the pillar supporting part **4210**, an active part or layer **4300** that is conformally formed over the plurality of pillars of pillar parts **4221-4226** and over the pillar supporting part **4210** between the plurality of pillars, and an n-type cladding **4400** that is conformally formed over an active layer **4300**, constitute a plurality of the columns **4600**. The plurality of the columns **4600** may be configured to maintain a space **4800** between each column of the plurality of columns **4600**. The metal electrode **4500** may be situated over a top of the plurality of columns **4600**. For example, the metal electrode **4500** may physically touch only an uppermost surface or face of each column **4700** of the plurality of columns **4600**.

According to the embodiments, the semiconductor light emitting diode can effectively increase the effective light emitting area by forming a cladding, including a pillar portion and a pillar support portion, and conformally forming an active layer on the pillar portion and the pillar support portion.

Also, according to the embodiments, the method for manufacturing the semiconductor light emitting diode can easily manufacture the foregoing semiconductor light emitting diode.

A semiconductor light emitting diode and a method for manufacturing the same according to embodiments have been described in detail with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein; rather, that alternate embodiments included in other retrogressive inventions or falling within the spirit and scope of the present disclosure can easily be derived through adding, altering, and changing, and will fully convey the concept of the invention to those skilled in the art.

What is claimed is:

1. A semiconductor light emitting diode comprising:

a pair of electrodes comprising a metal electrode and a transparent electrode, wherein the transparent electrode is disposed at a distance over the metal electrode;

an n-type cladding over the metal electrode, the n-type cladding comprising a pillar support part formed of an n-type semiconductor material, and a plurality of pillars formed of an n-type semiconductor material over the pillar support part, wherein a height of the plurality of pillars exceeds a width of each pillar of the plurality of pillars, and wherein the pillar support part is disposed between the metal electrode and the plurality of pillars;

an active part conformally formed over the plurality of pillars so as to enclose the plurality of pillars and over the pillar support part between the plurality of pillars, the active part having a quantum well layer and a barrier layer stacked alternately; and

a p-type cladding conformally formed over the active part, the p-type cladding formed of a p-type semiconductor material,

wherein the plurality of pillars formed of the n-type semiconductor material, the active layer formed over the plurality of pillars and over the pillar support part, and the p-type cladding formed over the active part constitute a plurality of columns, wherein the plurality of columns are configured to maintain a space between each column of the plurality, and wherein the transparent electrode is disposed over the plurality of columns, the

transparent electrode physically touching only an uppermost surface of each column of the plurality of columns.

2. The semiconductor light emitting diode of claim 1, wherein the n-type cladding is formed of an n-type GaN, and the p-type cladding is formed of a p-type GaN.

3. The semiconductor light emitting diode of claim 1, wherein the active part comprises an AlGaN quantum well layer and an AlGaN barrier layer stacked alternately.

4. The semiconductor light emitting diode of claim 3, wherein the active part comprises a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately.

5. A semiconductor light emitting diode comprising:

a pair of electrodes comprising a transparent electrode and a metal electrode, wherein the metal electrode is disposed at a distance over the transparent electrode;

an n-type cladding over the transparent electrode, the n-type cladding comprising a pillar support part formed of an n-type semiconductor material, and a plurality of pillars formed of an n-type semiconductor material over the pillar support part, wherein a height of the plurality of pillars exceeds a width of each pillar of the plurality of pillars, and wherein the pillar support part is disposed between the transparent electrode and the plurality of pillars;

an active part conformally formed over the plurality of pillars so as to enclose the pillar part and over the pillar support part between the plurality of pillars, the active part having a quantum well layer and a barrier layer stacked alternately; and

a p-type cladding conformally formed over the active part, the p-type cladding formed of a p-type semiconductor material,

wherein the plurality of pillars formed of the n-type semiconductor material, the active layer formed over the plurality of pillars and over the pillar support part, and the p-type cladding formed over the active part constitute a plurality of columns, wherein the plurality of columns are configured to maintain a space between each column of the plurality, and wherein the metal electrode is disposed over the plurality of columns, the metal electrode physically touching only an uppermost surface of each column of the plurality of columns.

6. The semiconductor light emitting diode of claim 5, wherein the n-type cladding is formed of an n-type GaN, and the p-type cladding is formed of a p-type GaN.

7. The semiconductor light emitting diode of claim 5, wherein the active part comprises an AlGaN quantum well layer and an AlGaN barrier layer stacked alternately.

8. The semiconductor light emitting diode of claim 7, wherein the active part comprises a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately.

9. A semiconductor light emitting diode comprising:

a pair of electrodes comprising a metal electrode and a transparent electrode, wherein the transparent electrode is disposed at a distance over the metal electrode;

a p-type cladding over the metal electrode, the p-type cladding comprising a pillar support part formed of a p-type semiconductor material, and a plurality of pillars formed of a p-type semiconductor material over the pillar support part, wherein a height of the plurality of pillars exceeds a width of each pillar of the plurality of pillars, and wherein the pillar support part is disposed between the metal electrode and the plurality of pillars;

an active part conformally formed over the plurality of pillars so as to enclose the plurality of pillars and over the pillar support part between the plurality of pillars, the active part having a quantum well layer and a barrier layer stacked alternately; and

an n-type cladding conformally formed over the active part, the n-type cladding formed of an n-type semiconductor material,

wherein the plurality of pillars formed of the p-type semiconductor material, the active layer formed over the plurality of pillars and over the pillar support part, and the n-type cladding formed over the active part constitute a plurality of columns, wherein the plurality of columns are configured to maintain a space between each column of the plurality, and wherein the transparent electrode is disposed over the plurality of columns, the transparent electrode physically touching only an uppermost surface of each column of the plurality of columns.

10. The semiconductor light emitting diode of claim 9, wherein the n-type cladding is formed of an n-type GaN, and the p-type cladding is formed of a p-type GaN.

11. The semiconductor light emitting diode of claim 9, wherein the active part comprises an AlGaN quantum well layer and an AlGaN barrier layer stacked alternately.

12. The semiconductor light emitting diode of claim 11, wherein the active part comprises a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately.

13. A semiconductor light emitting diode comprising:

a pair of electrodes comprising a metal electrode and a transparent electrode, wherein the metal electrode is disposed at a distance over the transparent electrode;

a p-type cladding over the transparent electrode, the p-type cladding comprising a pillar support part formed of a p-type semiconductor material, and a plurality of pillars formed of a p-type semiconductor material over the pillar support part, wherein a height of the plurality of pillars exceeds a width of each pillar of the plurality of pillars, and wherein the pillar support part is disposed between the transparent electrode and the plurality of pillars;

an active part conformally formed over the plurality of pillars so as to enclose the plurality of pillars and over the pillar support part between the plurality of pillars, the active part having a quantum well layer and a barrier layer stacked alternately; and

an n-type cladding conformally formed over the active part, the n-type cladding formed of an n-type semiconductor material,

wherein the plurality of pillars formed of the p-type semiconductor material, the active layer formed over the plurality of pillars and over the pillar support part, and the n-type cladding formed over the active part constitute a plurality of columns, wherein the plurality of columns are configured to maintain a space between each column of the plurality, and wherein the metal electrode is disposed over the plurality of columns, the metal electrode physically touching only an uppermost surface of each column of the plurality of columns.

14. The semiconductor light emitting diode of claim 13, wherein the n-type cladding is formed of an n-type GaN, and the p-type cladding is formed of a p-type GaN.

15. The semiconductor light emitting diode of claim 13, wherein the active part comprises an AlGaN quantum well layer and an AlGaN barrier layer stacked alternately.

16. The semiconductor light emitting diode of claim 15, wherein the active part comprises a plurality of AlGaN quantum well layers and a plurality of AlGaN barrier layers stacked alternately.

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